2015 AHA /ECC updates for BLS:

Compression rate and depth - how to perform and monitor

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Reinforced

- Chest compressions are the key component of effective CPR.
- Characteristics of chest compressions include their rate, depth, and degree of recoil.
- The quality of CPR can also be characterized by the frequency and duration of interruptions (chest compression fraction), and avoid excessive ventilation.

Reinforced

- These CPR elements affect intra-thoracic pressure, coronary perfusion pressure, cardiac output, and in turn, clinical outcome.
- More data are available showing that high-quality CPR improves survival from cardiac arrest.

High quality CPR

- Ensuring chest compressions of adequate rate
- Ensuring chest compressions of adequate depth
- Allowing full chest recoil between compressions
- Minimizing interruptions in chest compressions
- Avoiding excessive ventilation

CPR Quality Overview

- Other important aspects of CPR quality:
  - Resuscitation team dynamics
  - System performance
  - Quality monitoring

Reinforced
CPR cycle remains C-A-B

- Emphasis placed on trained rescuers performing ventilations and non-trained perform chest compression only.

Reinforced
Hand Position During Compressions

- Consistent with the 2010 Guidelines, it is reasonable to position hands for chest compressions on the lower half of the sternum in adults with cardiac arrest (Class IIa, LOE C-LD).

Reinforced Hand Position During Compressions

- Different rescuer hand positions alter the mechanics of chest compressions and may, in turn, influence their quality and effectiveness.
- A few human studies have not provided conclusive or consistent results about the effects of hand placement on resuscitation outcome.

Updated
Chest Compression Rate

- In adult victims of cardiac arrest, it is reasonable for rescuers to perform chest compressions at a rate of 100/min to 120/min (Class IIa, LOE C-LD)
- In the 2010 Guidelines, the recommended rate was at least 100/min.

Updated
Chest Compression Rate

- Chest compression rate is defined as the actual rate used during each continuous period of chest compressions.
- The rate differs from the number of chest compressions delivered per unit of time, which takes into account any interruptions in chest compressions.

Chest Compression Rate
2015 summary of evidence

- Human studies that evaluate the relationship between compression rate and outcomes including survival to hospital discharge, ROSC, and various physiologic measures, such as BP and ET-CO_2.
- An optimal zone for the compression rate – between 100 - 120/min – that on average is associated with improved survival.

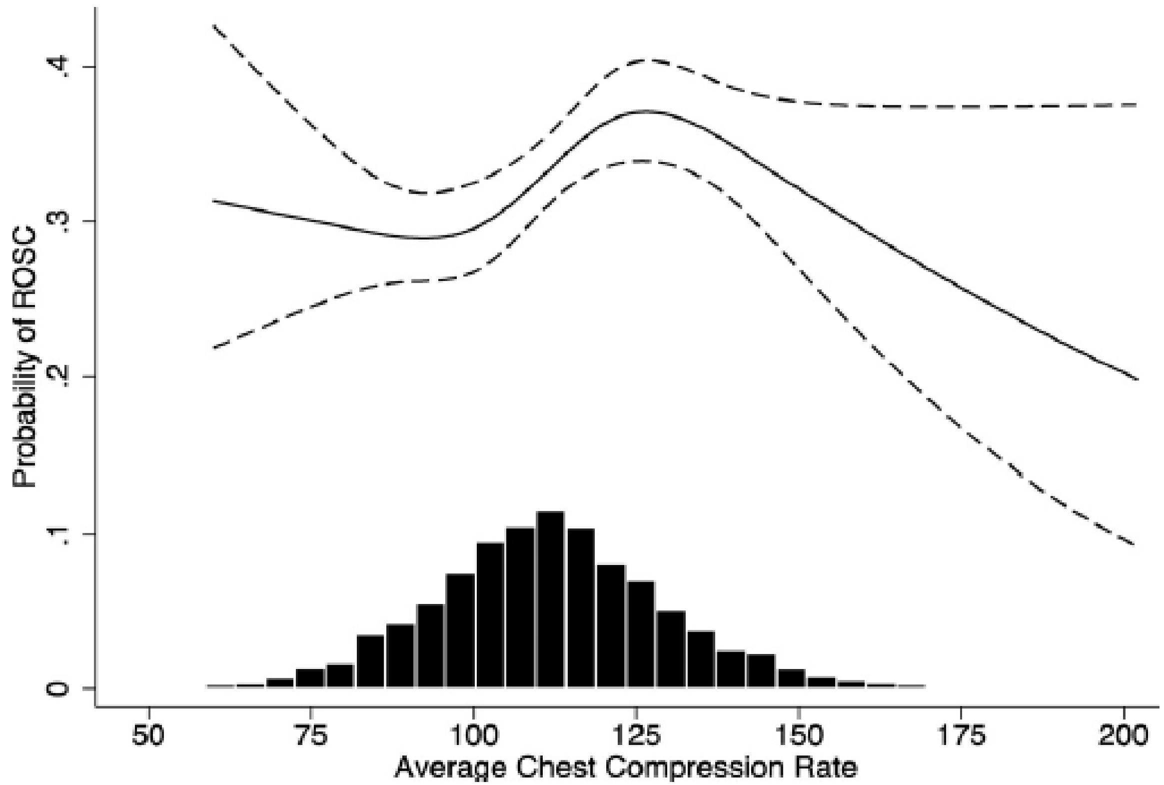


Figure 3. Adjusted cubic spline of the relationship between chest compression rates and the probability of return of spontaneous circulation (ROSC). The adjusted model includes sex, age, bystander-witnessed arrest, emergency medical services–witnessed arrest, first known emergency medical services rhythm, attempted bystander cardiopulmonary resuscitation, public location, and site location (*y* axis). Probability of ROSC vs average chest compression rate when other covariates are equal to the population average is shown. We used a global test that tested the null hypothesis that the spline curve is a horizontal line (P=0.012). A histogram of the compression rates and numbers of patients is included. Dashed lines show 95% confidence intervals.

Circulationh 2012;125:3004-3012

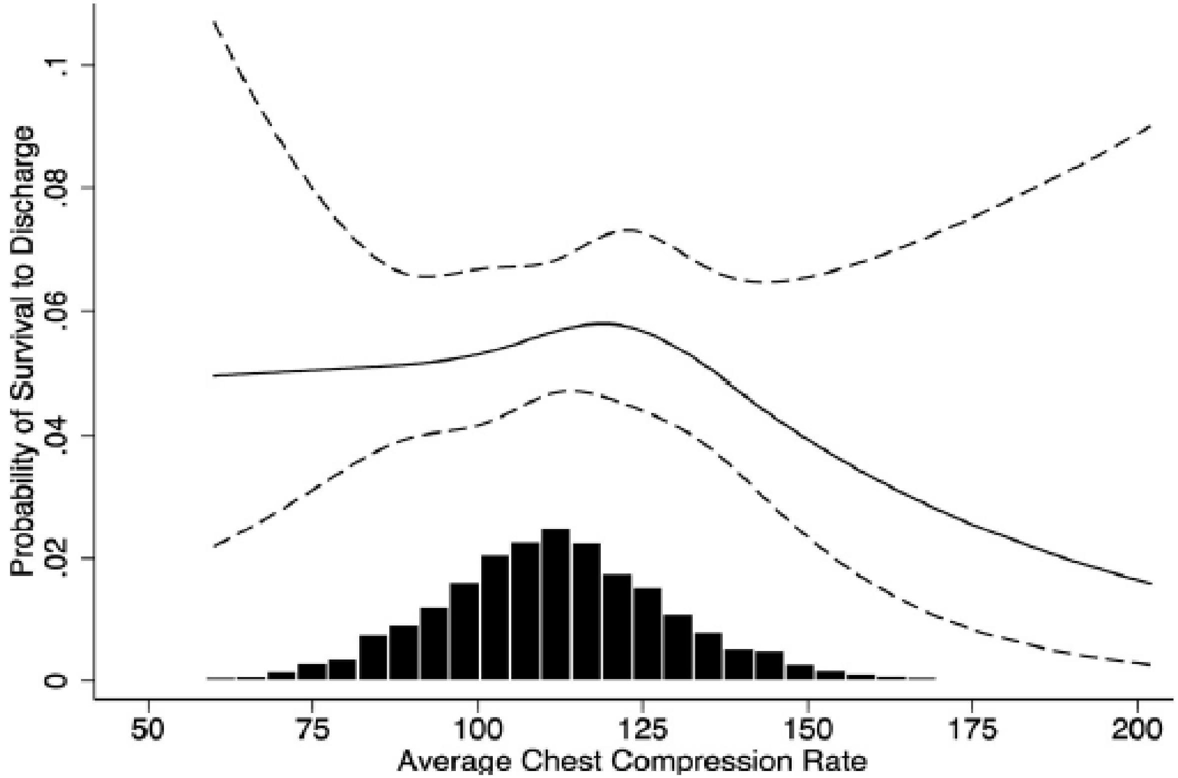


Figure 4. Adjusted cubic spline of the relationship between chest compression rates and the probability of survival to hospital discharge. The adjusted model includes sex, age, bystander-witnessed arrest, emergency medical services–witnessed arrest, first known emergency medical services rhythm, attempted bystander cardiopulmonary resuscitation, public location, and site location (*y* axis). Probability of survival vs average chest compression rate when other covariates are equal to the population average is shown. We used a global test that tested the null hypothesis that the spline curve is a horizontal line (P=0.63). A histogram of the compression rates and numbers of patients is included. Dashed lines show 95% confidence intervals.

Circulationh 2012;125:3004-3012

Chest Compression Rate 2015 summary of evidence

- An interdependent relationship between compression rate and depth.
- As rate increases to greater than 120/min, depth decreases in a dose-dependent manner.
- The proportion of compressions less than 3.8 cm (1.5 inches) was about 35% for a rate of 100 to 119/min, but increased to 50% for a rate of 120 to 139/min, and 70% for a rate of greater than 140/min.

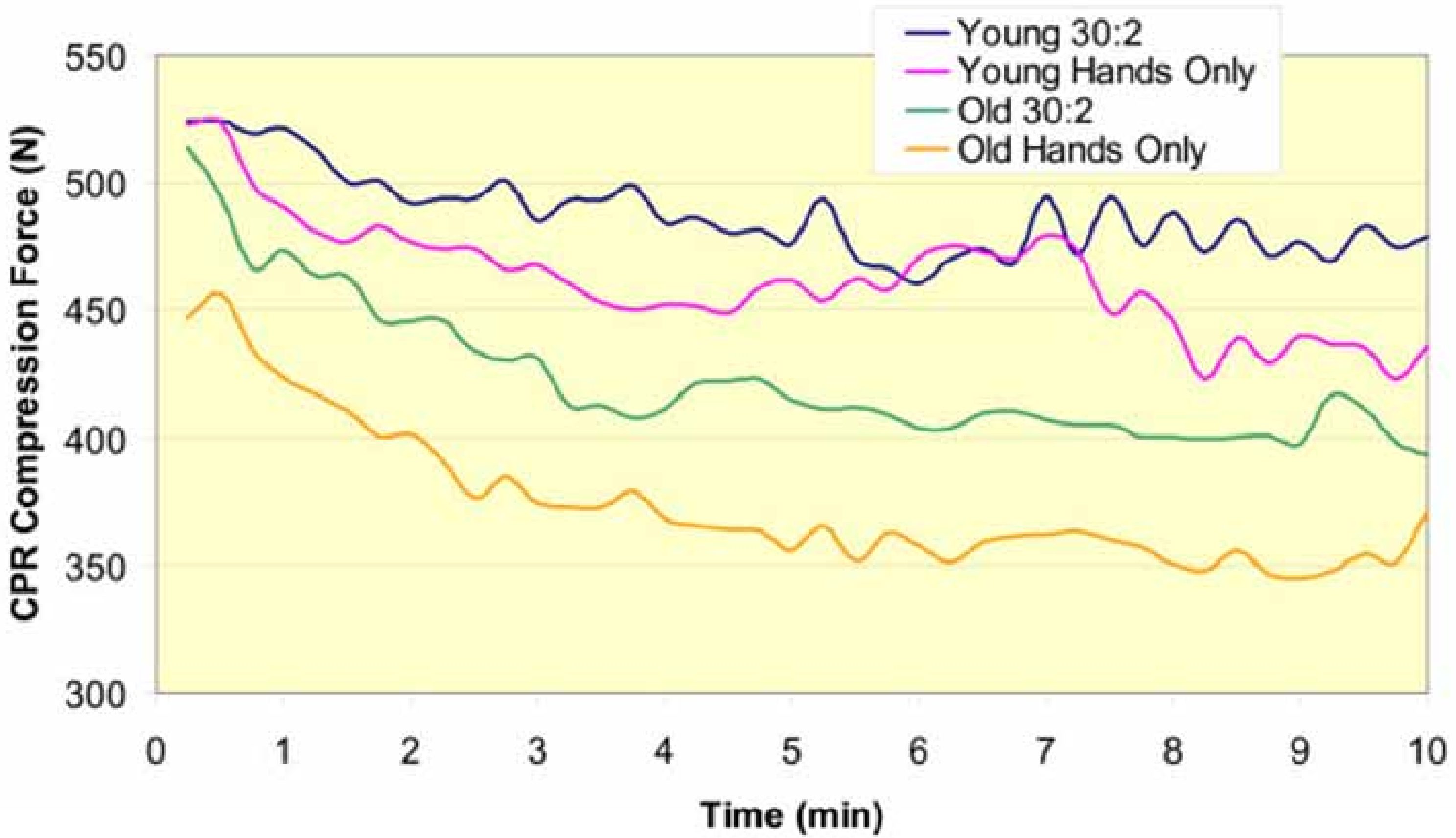


Figure 4

Average compression forces across time for younger and older subjects performing Hands-Only and 30:2 CPR.

Updated
Chest compression depth

- The compression depth can affect the relative increase in intrathoracic pressure and , in turn, influence forward blood flow from the heart and great vessels to the systemic circulation.

Updated
Chest compression depth

- During manual CPR, rescuers should perform chest compressions to a depth of at least 2 inches or 5 cm for an average adult, while avoiding excessive chest compression depths (greater than 2.4 inches or 6 cm). (Class I, LOE C-LD)
- In the 2010 Guidelines, the recommended depth was at least 2 inches (5 cm).

Chest Compression Depth
2015 summary of evidence

- Human studies that evaluate the relationship between compression depth and outcomes including survival with favorable neurologic outcome, survival to hospital discharge, and ROSC.
- Classify depth differently, using distinct categories of depth or using an average depth for a portion of the resuscitation.

Chest Compression Depth 2015 summary of evidence

- There is consistent evidence that achieving depth of approximately 5 cm is associated with greater favorable outcome compared with shallower compressions.
- In the largest study to date (n= 9136), the optimal depth regard to survival occurred within the range of 4.1 to 5.5 cm (1.61 to 2.2 inches).

Chest Compression Depth
2015 summary of evidence

- Less evidence is available about whether there is an upper threshold beyond which compressions may be too deep.
- Injuries are more common when depth is greater than 6 cm (2.4 inches) than when it is between 5 to 6 cm.
- Chest compressions performed by professional rescuers are more likely to be too shallow (< 4 cm) and less likely to exceed 5.5 cm.

Updated
Infant /Child Compression rate

- For simplicity in CPR training, in the absence of sufficient pediatric evidence, it is reasonable to use the adult BLS-recommended chest compression rate of 100/min to 120/min for infants and children.

Reinforced
Infant / Child compression depth

- It is reasonable that for pediatric patients (birth to the onset of puberty) rescuers provide chest compressions that depress the chest at least one third the anterior-posterior diameter of the chest.
- This equates to approximately 1.5 inches (4 cm) infants to 2 inches (5 cm) in children (Class IIa, LOE C-LD).
- Once children have reached puberty, the recommended adult compression depth of at least 5 cm, but no more than 6 cm, is used for the adolescent of average adult size.

Reinforced Chest Wall Recoil

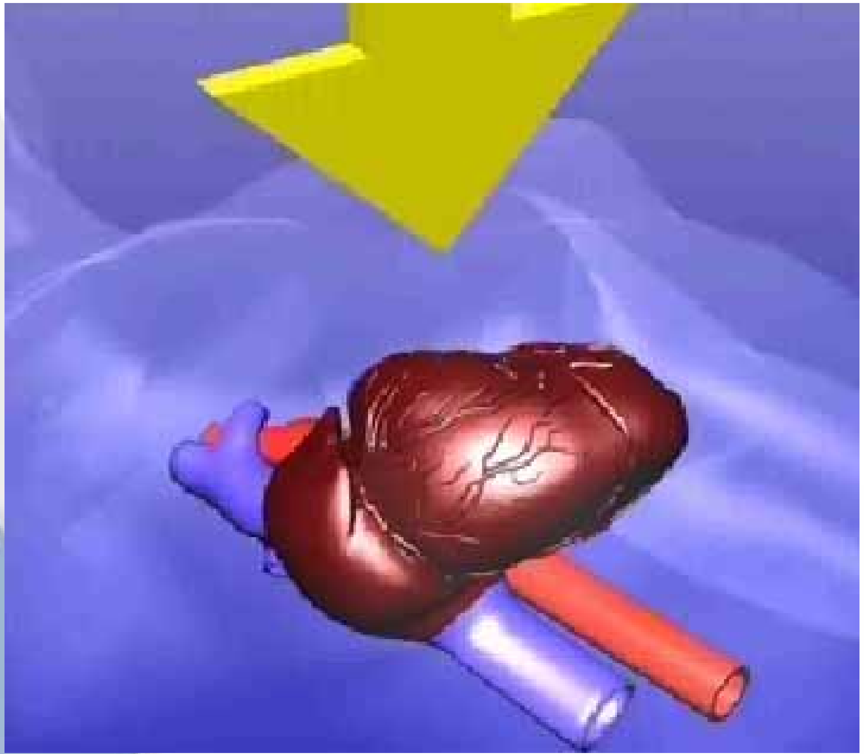
- It is reasonable for rescuers to avoid leaning on the chest between compressions to allow full chest wall recoil for adults in cardiac arrest. (Class IIa, LOE C-LD)

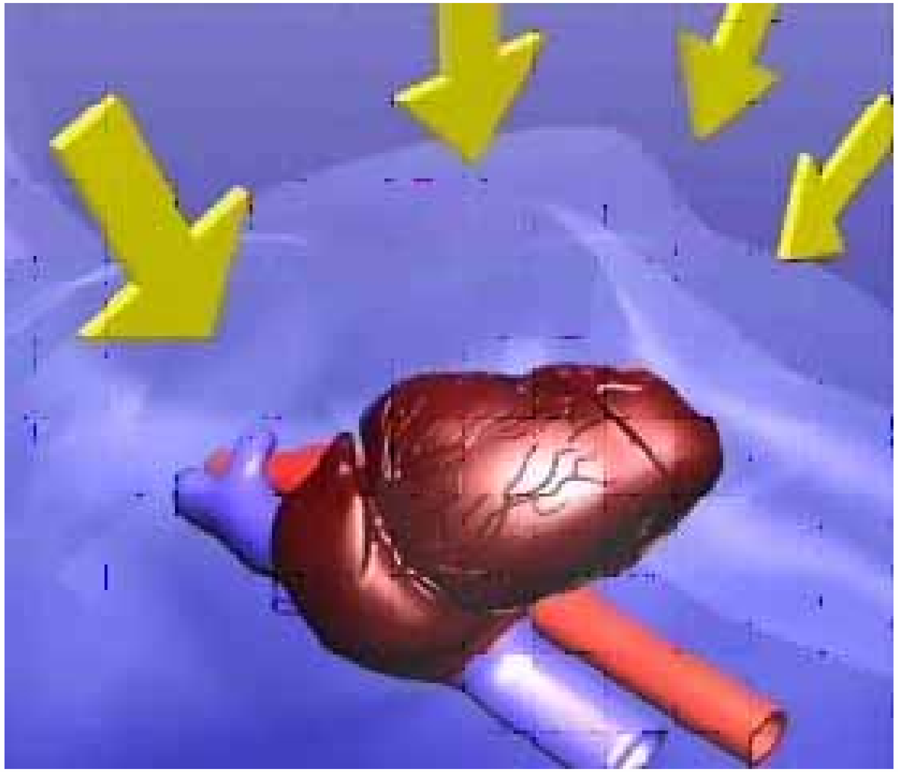
Reinforced Chest Wall Recoil

- Chest wall recoil creates a relative negative intra-thoracic pressure that promotes venous return and cardiopulmonary blood flow.
- Leaning on the chest wall between compressions precludes full chest wall recoil.
- Incomplete recoil could increase intra-thoracic pressure and reduce venous return, coronary perfusion pressure, and myocardial blood flow and potentially influence outcome.

Chest Wall Recoil
2015 summary of evidence

- Observational studies indicate that leaning is common during CPR.
- There are no human studies reporting the relationship between chest wall recoil and clinical outcome.
- 2 animal studies and a pediatric study of pts not in cardiac arrest. In all 3 studies, an increased force of leaning was associated with a dose-dependent decrease in CPP, but the relationship between leaning and cardiac output was inconsistent.





Minimizing Interruptions in Chest Compressions

- Interruptions in chest compressions can be intended as part of

➢ required care (ie, rhythm analysis and ventilation) or

➢ unintended (ie, rescuer distraction).

Table 1. Compression Pause Requirements for Resuscitation Tasks

Pause Requirement	Task
Generally required	Defibrillation Rhythm analysis Rotation of compressors Backboard placement Transition to mechanical CPR or ECMO
Sometimes required	Complicated advanced airway placement in patients who cannot be ventilated effectively by bag-valve-mask Assessment for return of spontaneous circulation
Generally not required	Application of defibrillator pads Uncomplicated advanced airway placement IV/IO placement

CPR indicates cardiopulmonary resuscitation; ECMO, extracorporeal membrane oxygenation; and IV/IO, intravenous/intraosseous.

Circulationh 2013;128:417-435

Reinforced
Minimizing Interruptions in Chest Compression during AED use

- In adult cardiac arrest, total preshock and postshock pauses in chest compressions should be as short as possible.(Class IIa, LOE C-LD).
- It may be reasonable to immediately resume chest compressions after shock delivery for adults in cardiac arrest in any setting.

Reinforced
Minimizing Interruptions in Chest Compression during breaths.

- For adults in cardiac arrest receiving CPR without an advanced airway, it is reasonable to pause compressions for less than 10 seconds to deliver 2 breaths. (Class IIa, LOE C-LD)

Reinforced
Minimizing Interruptions in Chest Compressions

- In adult cardiac arrest with an unprotected airway, it may be reasonable to perform CPR with the goal of a chest compression fraction as high as possible, with a target of at least 60%. (Class IIb, LOE C-LD)

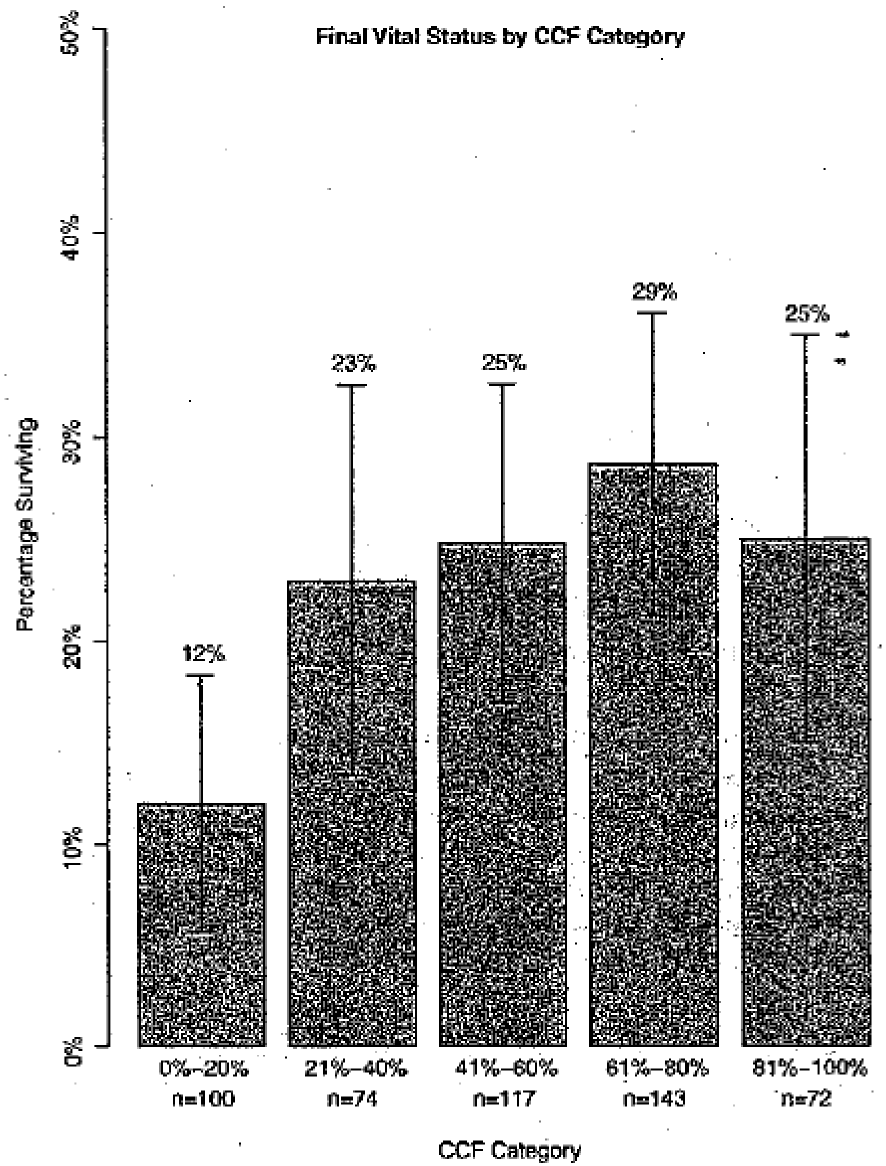


Figure 2. Survival to discharge for each category of chest compression fraction.

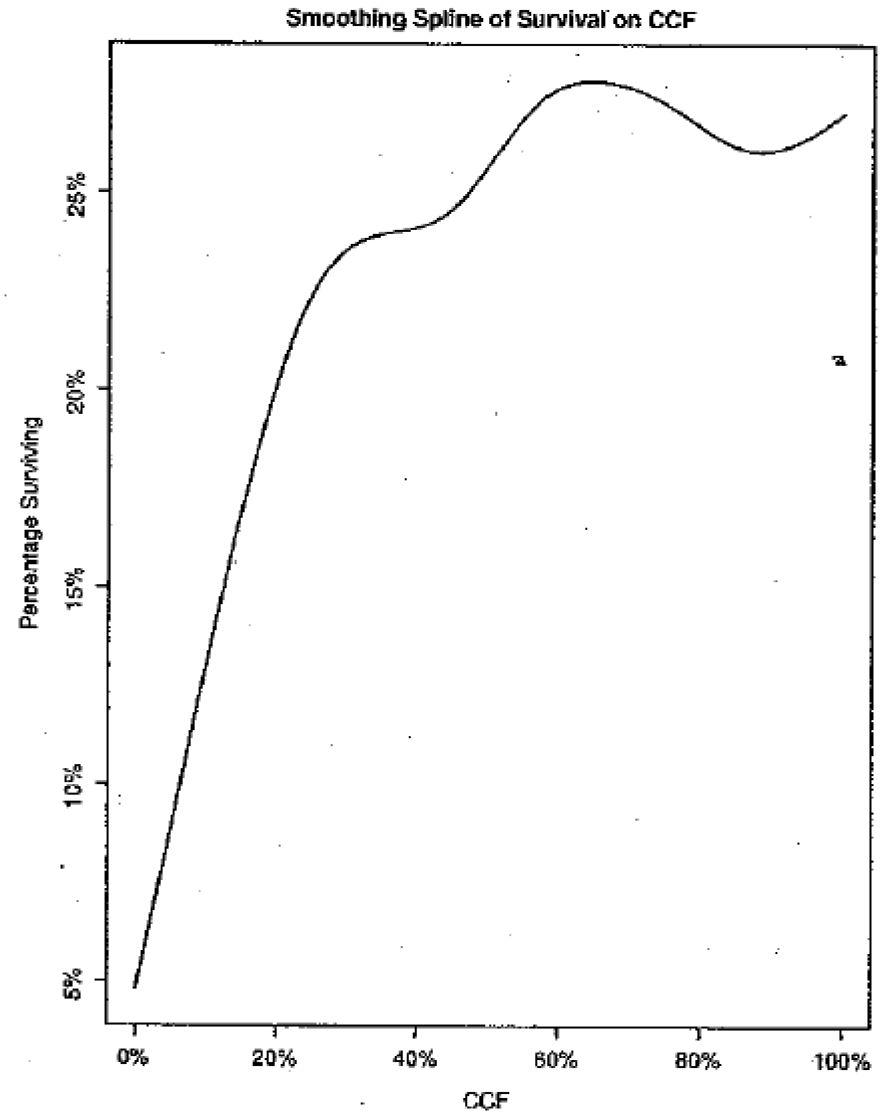


Figure 3. Smoothing spline representing the incremental probability of survival corresponding to a linear increase in chest compression fraction.

Circulation 2009;120:1241-1247

Minimizing Interruptions in Chest Compressions

- Compression fraction is a measurement of the proportion of time that compressions are performed during a cardiac arrest.
- An increase in fraction can be achieved by minimizing pauses in compressions.
- The AHA expert consensus is that a compression fraction of 80% is achievable in a variety of settings.

Minimizing Interruptions in Chest Compressions 2015 summary of evidence

- Observational studies demonstrate an association between a shorter duration of interruption for the peri-shock period and a greater shock success, ROSC, and survival to hospital discharge.
- An association between higher chest compression fraction and likelihood of survival among pts with shockable rhythms, and ROSC among patients with non-shockable rhythms.

CPR Quality, Accountability, and Healthcare Systems

- Few healthcare organizations consistently apply strategies of systematically monitoring CPR quality.

CPR Quality, Accountability, and Healthcare Systems

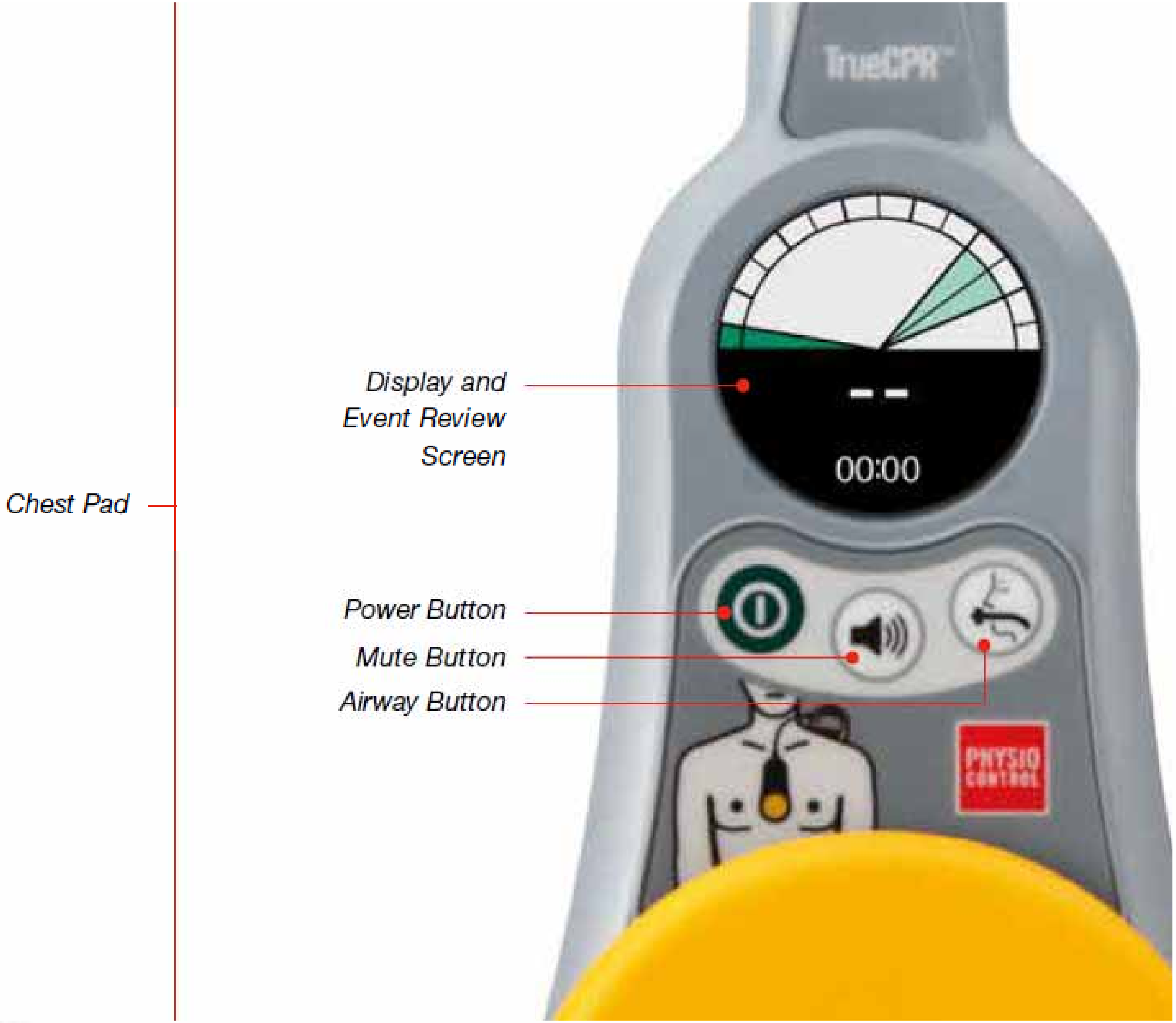
- The use of a relatively simple, iterative continuous quality improvement approach to CPR can dramatically improve CPR quality and optimize outcome.
- Similar to successful approaches toward mitigating medical errors, programs aimed at system-wide CPR data collection, implementation of best practices, and continuous feedback on performance have been shown to be effective.

Updated
Chest Compression Feedback

- It may be reasonable to use audiovisual feedback devices during CPR for real-time optimization of CPR performance (Class IIb, LOE B-R).

Audiovisual Feedback Devices during CPR

TrueCPR™
COACHING DEVICE


TrueCPR
Display and
Event Review
Screen
00:00
Chest Pad
Power Button
Mute Button
Airway Button
PHYSIO
CONTROL

Mute Button
Airway Button
Readiness Indicator
USB Port Cover
PHYSIO CONTROL

3 Levels of CPR Feedback (Coaching Device)

- Real-Time → during
- Post-Evemt → summary on data
- Post-Event → Analysis and Review

Updated
Chest Compression Feedback

- Real-time monitoring, recording, and feedback about CPR quality, including both physiologic patient parameters and rescuer performance metrics.
- This data can be used in:

➢Real time during resuscitation

➢For debriefing after resuscitation

➢For system-wide quality improvement program

During chest compressions

TrueCPR shows a CPR provider exactly how they're doing, right where they are looking—at the patient's chest. Compression depth, rate and recoil are displayed in real time on a highly visible dial. In addition, a CPR metronome and ventillation prompts help guide responders to provide CPR per Guidelines' recommended rates.

Immediately after an event

Important summary statistics such as average rate, percentage of compressions at the correct depth and recoil, hands-on time and total event time are displayed on the easy-to-read TrueCPR dial and provide a snapshot of event performance.

Post-event review and debriefing

TrueCPR captures up to 180 minutes of CPR information, which can easily be assessed with Physio-Control data review software to help evaluate overall performance and establish a critical team feedback loop for continuous CPR improvement.

Updated
Chest Compression Feedback

- Feedback devices may be effective in modifying chest compression rates, decreases the leaning force during compressions.
- Feedback devices has not been shown to significantly improve performance of compression depth, fraction and ventilation rate.
- Studies to date have not demonstrated a significant improvement in favorable neurologic outcome or survival to hospital discharge related to the use of feedback devices during actual cardiac arrest events.

- Life saving quality CPR is dependent on several coordinatd factors as in the Quality Circle:

- Therapy - audiovisual feedback during resuscitation with the HeartStart MRx with Q-CPR technology.
- Training - initial and maintenance training with the Resusci Anne Q-CPR/D training system.
  - self-directed training and certification with Anne Skills Station.
- Evaluation - post event debriefing of the training and therapy with Event Review Pro and Q-CPR Review.

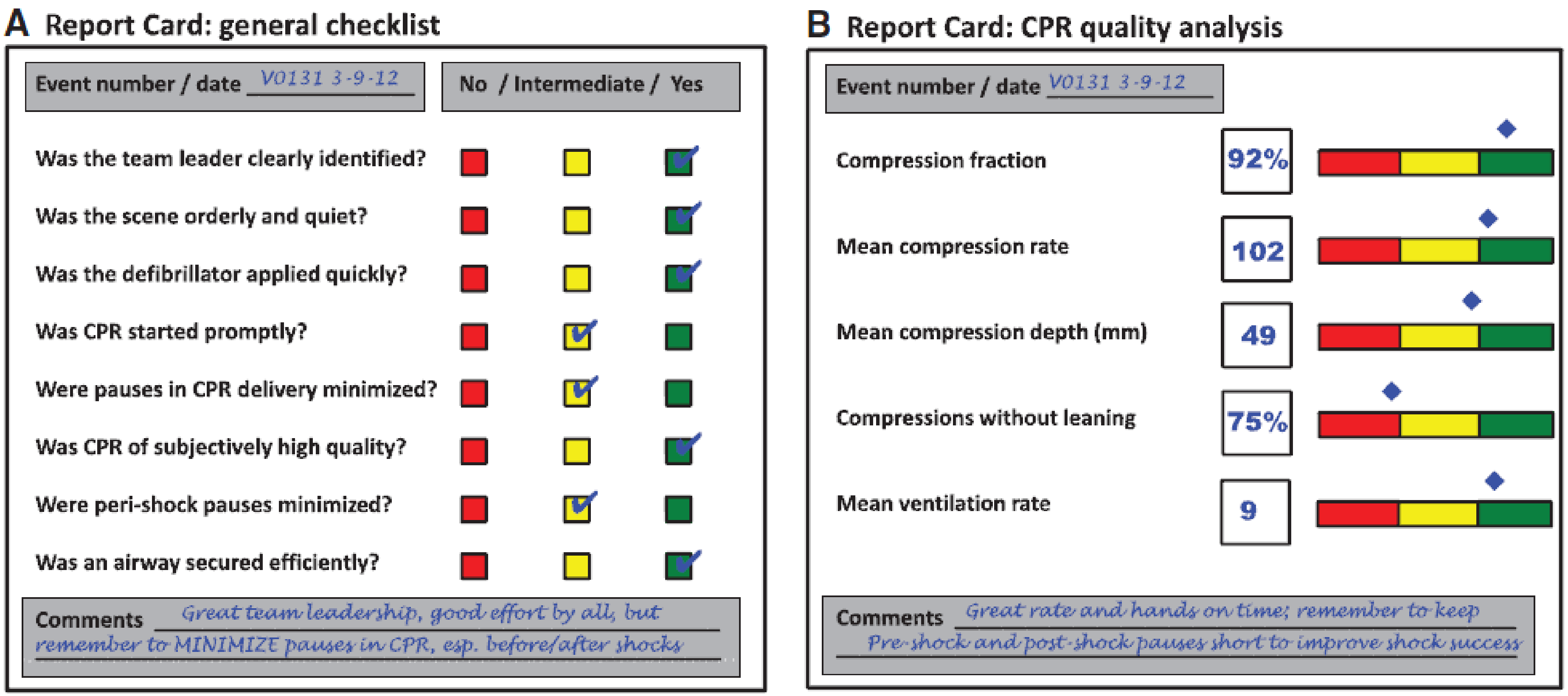


Figure 1. Illustration of proposed resuscitation "report cards." Routine use of a brief tool to document resuscitation quality would assist debriefing efforts and quality improvement efforts for hospital and emergency medical services systems. **A**, General checklist. Example of a general checklist report card that could be completed by a trained observer to a resuscitation event. **B**, CPR quality analysis. Example of a report card that relies on objective recording of CPR metrics. Ideally, both observational (**A**) and objective (**B**) reports could be used together in a combined report. CPR indicates cardiopulmonary resuscitation.

Circulationh 2013;128:417-435

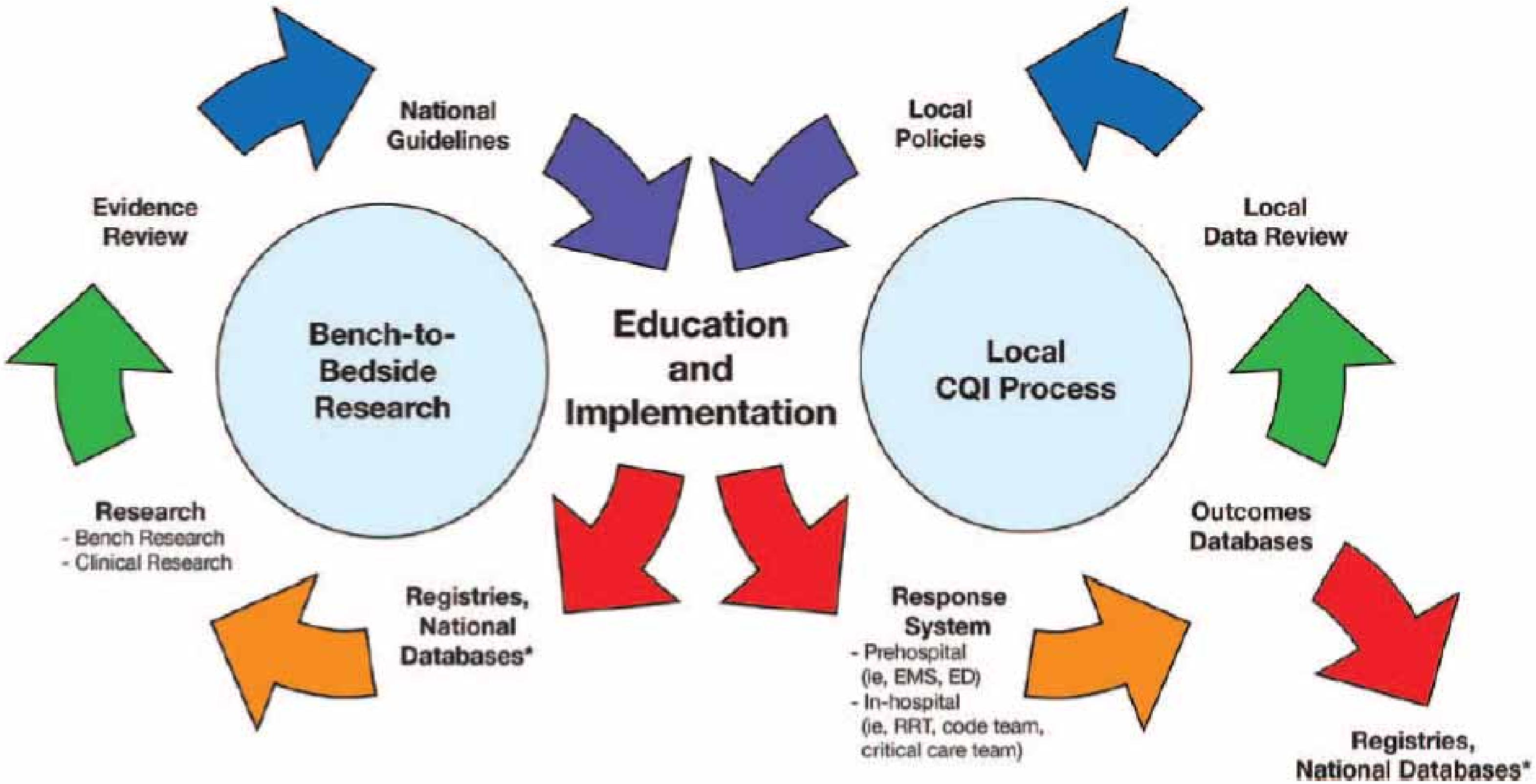


Figure 2. A continuous process evaluates and improves clinical care and generates new guidelines and therapy. Outcome data from cardiac arrest and periarrest periods are reviewed in a continuous quality-improvement (CQI) process. Research and clinical initiatives are reviewed periodically in an evidence-based process. Experts then evaluate new therapy and make clinical and educational recommendations for patient care. The process is repeated, and continual progress and care improvements are generated. ED indicates emergency department; EMS, emergency medical services; and RRT, rapid response team. *This is an overlap point in the cycle. That is, data come from outcomes databases (shown on the right) and go into registries and national databases (shown on the left).

Circulationh 2013;128:417-435

Future Directions Need to Improve CPR Quality: Research

- To determine the optimal targets for CPR characteristics (CCF, compression rate and depth, lean, and ventilation), as well as their relative importance to patient outcome
- To determine the effect of a victim's age and cause of arrest on optimal CPR characteristics (especially initiation and method of ventilation)
- To further characterize the relationships between individual CPR characteristics
- To further characterize which CPR characteristics and relationships between them are time dependent
- To determine the impact of the variability during the arrest of CPR characteristics (especially CCF and depth) on patient outcome
- To clarify whether ventilation characteristics (time-, pressure-, volume-based parameters) during CPR impact patient outcome
- To determine optimal titration of hemodynamic and ETCO2 monitoring during human CPR
- To determine whether ETCO2 monitoring of a noninvasive airway is a reliable and useful monitor of CPR quality
- To determine optimal relationship between preshock CPR characteristics (ie, depth, pause) and ROSC/survival
- To determine the optimal number of rescuers and the effect of rescuer characteristics on CPR quality and patient outcome
- To further characterize the impact of provider fatigue and recovery on patient outcome
- To determine the impact of work environment, training environment, and provider characteristics on CPR performance and patient survival
- To clarify methods of integration of CPR training into advanced courses and continuing maintenance of competency
- To determine the method of education, as well as its timing and location, at a system level to ensure optimal CPR performance and patient outcome
- To develop a global CPR metric that can be used to measure and optimize educational and systems improvement processes

Future Directions Need to Improve CPR Quality: Development

- To standardize the reporting of CPR quality and the integration of these data with existing systems improvement processes and registries
- To develop a device with the ability to measure and monitor CPR quality during training and delivered in real events and integrate it with existing quality improvement and registries
- To develop optimal CPR systems improvement processes that provide reliable, automated reporting of CPR quality parameters with the capacity for continuous CPR quality monitoring in all healthcare systems
- To develop feedback technology that prioritizes feedback in an optimal manner (eg, correct weighting and prioritization of the CPR characteristics themselves)
- To develop a more reliable, inexpensive, noninvasive physiological monitor that will increase our ability to optimize CPR for individual victims of cardiac arrest
- To develop training equipment that provides rescuers with robust skills to readily and reliably provide quality CPR
- To develop improved mechanical systems of monitoring CPR, including consistent and reliable capture of ventilation rate, tidal volume, inspiratory pressure, and duration, as well as complete chest recoil

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